NEXT-TIME QUESTION

CONCEPTUAL Physics

HE CAN QUICKLY WALK BAREFOOT ACROSS RED HOT COALS OF WOOD WITHOUT HARM BECAUSE OF

a) MIND OF MATTER.
b) REASONS THAT ARE OUTSIDE MAINSTREAM PHYSICS.
c) BASIC PHYSICS CONCEPTS.

Hewitt Drew it!

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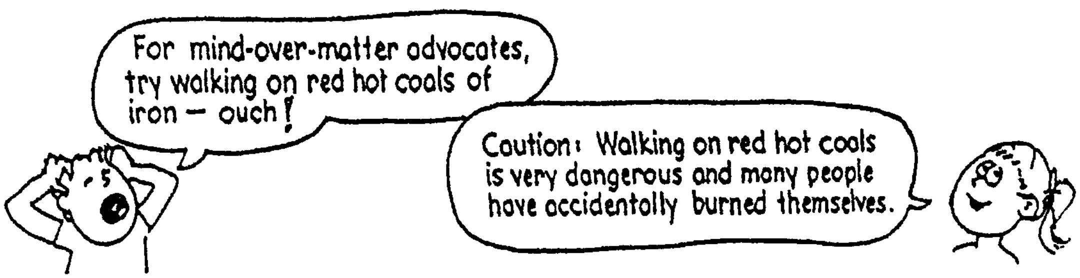
Answer: c

First of all, the coals are wood, a very poor conductor of heat. Wood is a poor conductor even when it's hot, which is why wooden handles are used on cookware. Even when the wood is red hot, its poor conductivity allows quick steps without the transfer of very much heat. High temperature and how much heat transfers are entirely different physics concepts. Secondly, if your feet are damp because of perspiration or wet surrounding grass, even less heat is transferred to your feet. Why? Two reasons: Some of the heat energy goes into evaporating the moisture that would otherwise burn you—and when the moisture turns to vapor it provides an insulating blanket. This is why you wet your finger before touching a hot clothes iron.



Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

COMMON GRANITE ROCK CONTAINS TRACE AMOUNTS OF URANIUM AND OTHER RADIOACTIVE MINERALS RELEASING ABOUT 0.03 JOULES OF ENERGY PER KILOGRAM EACH YEAR. GRANITE AT THE EARTH'S SURFACE TRANSFERS THIS ENERGY TO THE SURROUNDINGS PRACTICALLY AS FAST AS IT IS GENERATED, SO WE DON'T FIND GRANITE PARTICULARLY WARM. BUT THE ROCK IN THE EARTH'S INTERIOR, WHICH IS MORE INSULATED GETS QUITE WARM—HOT ENOUGH TO KEEP THE INTERIOR MOLTEN HEAT LAVA, AND PROVIDE WARMTH TO NATURAL HOT SPRINGS.

1. About how many years are required for a chunk of thermally insulated granite to increase 500°C in temperature (assume the specific heat of granite is 800 J/kg·C°)?

2. Why doesn't the ratioactive process continue and melt the whole Earth?

Hewitt Drew it!

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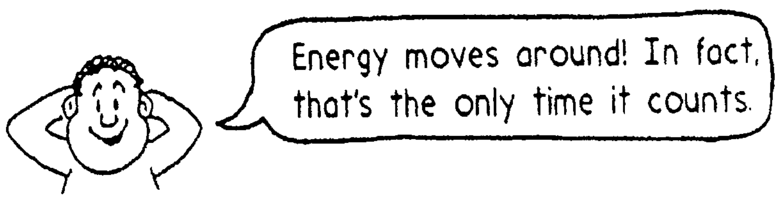
Answers

1. To heat granite by 500°C takes 500°C × 800 J/kg·C° = 400,000 joules per kilogram of rock. So the time required is [400,000 J/kg] / [0.03 J/kg·yr] = 13.3 million years. Small wonder it stays hot down there!

2. The process does continue, but because the Earth's interior is far from being perfectly insulated, heat migrates to the surface. There it eventually goes into space by terrestrial radiation.



Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

Which of these continually emits electromagnetic radiation?

a) An un-lit flashlight bulb.
b) A hot steam radiator.
c) A tray of ice cubes.
d) None do.
e) All do.

Hewitt Drew it!

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Conceptual Physics

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c) A tray of ice cubes.

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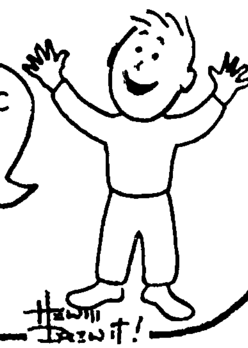
e) All do.

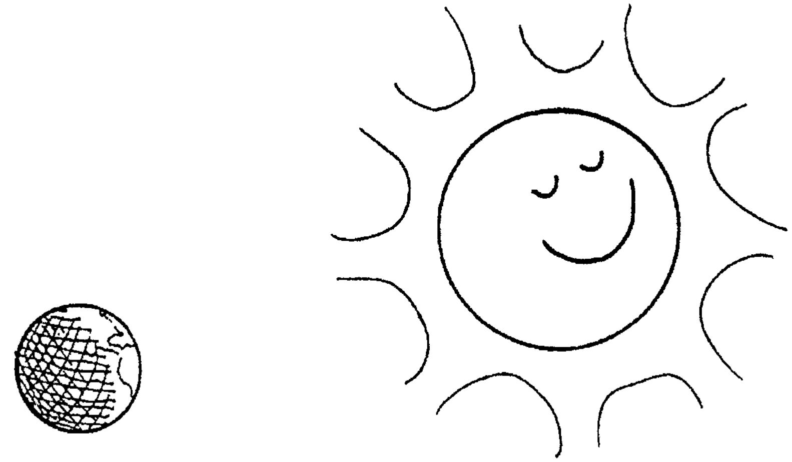
Answer: e.

All bodies with any temperature whatever continually emit electromagnetic radiation. The frequency of the emitted radiation varies with temperature. The rule is $\bar{f} \sim T$, where $\bar{f}$ is the peak frequency of emitted radiation and T is the absolute temperature of the body emitting it. The bodies listed have relatively low temperatures so they emit relatively low frequencies — infrared. If you raise their temperatures sufficiently, their radiation will be visible light.

All bodies in nature, you, me, and all things, both emit and receive electromagnetic radiation continuously. When a body emits more than it receives, its temperature drops. When it receives more than it emits, its temperature increases. At any constant temperature a body emits as much as it receives. Nature is dynamic.



NEXT-TIME QUESTION



WHICH BODY GLOWS WITH RADIANT ENERGY THAT HAS ITS SOURCE IN NUCLEAR PROCESSES IN THE INTERIOR OF THE BODY?

a) SUN
b) EARTH
c) BOTH
d) NEITHER

Hewitt Drew it!

NEXT-TIME QUESTION

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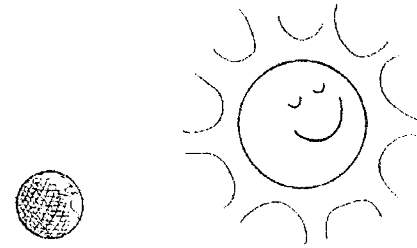
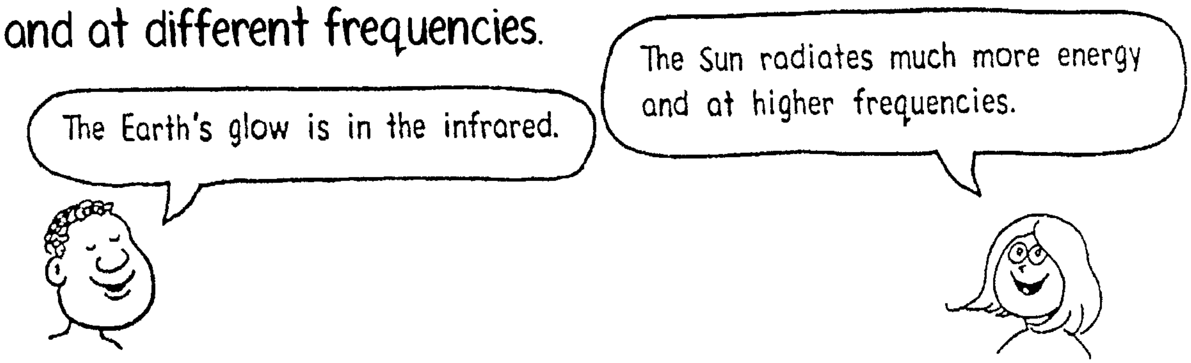


Answer: c

Both glow with the same type of radiation, electromagnetic waves, with energy that originates in the interiors from nuclear processes. The Sun is heated by fusion of hydrogen nuclei to make helium. The Earth is heated by radioactive decay of heavy elements deep underground. Both bodies are powered by nuclear processes, and both radiate the produced energy—but in vastly different quantities and at different frequencies.



Hewitt Drew it!

NEXT-TIME QUESTION

SUPPOSE IN A RESTAURANT YOUR COFFEE IS SERVED ABOUT 5 OR 10 MINUTES BEFORE YOU ARE READY FOR IT. IN ORDER THAT IT BE AS HOT AS POSSIBLE WHEN YOU DRINK IT, SHOULD YOU POUR IN THE ROOM TEMPERATURE CREAM RIGHT AWAY OR WHEN YOU ARE READY TO DRINK THE COFFEE?

Hewitt Drew it!

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Answer: Right away

In so doing, you lighten the color of the coffee. When the coffee is black, it is a better radiator and will cool faster than when it is lighter in color. Perhaps you can think of some other reasons for pouring the cream right away.

Hewitt Drew it!

NEXT-TIME QUESTION

WHY IS IT SIGNIFICANTLY COLDER ON A WINTER NIGHT UNDER A CLEAR SKY THAN UNDER A CLOUDY SKY?

thanx to Rick Lucas

Hewitt Drew it!

NEXT-TIME QUESTION

WHY IS IT SIGNIFICANTLY COLDER ON A WINTER NIGHT UNDER A CLEAR SKY THAN UNDER A CLOUDY SKY?

Answer

We all know that energy from the glowing Sun affects temperature here on Earth. Almost as important but less well known, is energy emitted by the "glowing" Earth. Like the Sun, the Earth glows—but only in the infrared. This is terrestrial radiation—lower in both frequency and intensity than solar radiation. On a clear night, terrestrial radiation escapes through the atmosphere, which lowers the temperature of the Earth's surface and the air near it. But on a cloudy night, much terrestrial radiation is absorbed by the clouds and reradiated back to the Earth, countering a nightly lowering of temperature.

We see why frost forms on a lawn under a clear night sky, but not under a park bench or a grove of trees. The bench and trees reradiate terrestrial radiation to the ground, keeping it warmer.

We also see why fruit growers use smudgepots in orchards on frosty nights. The dark smudgy cloud close to the ground absorbs terrestrial radiation and reradiates it, keeping the air and fruit above freezing. This marks time until sunlight comes to the rescue the following morning!

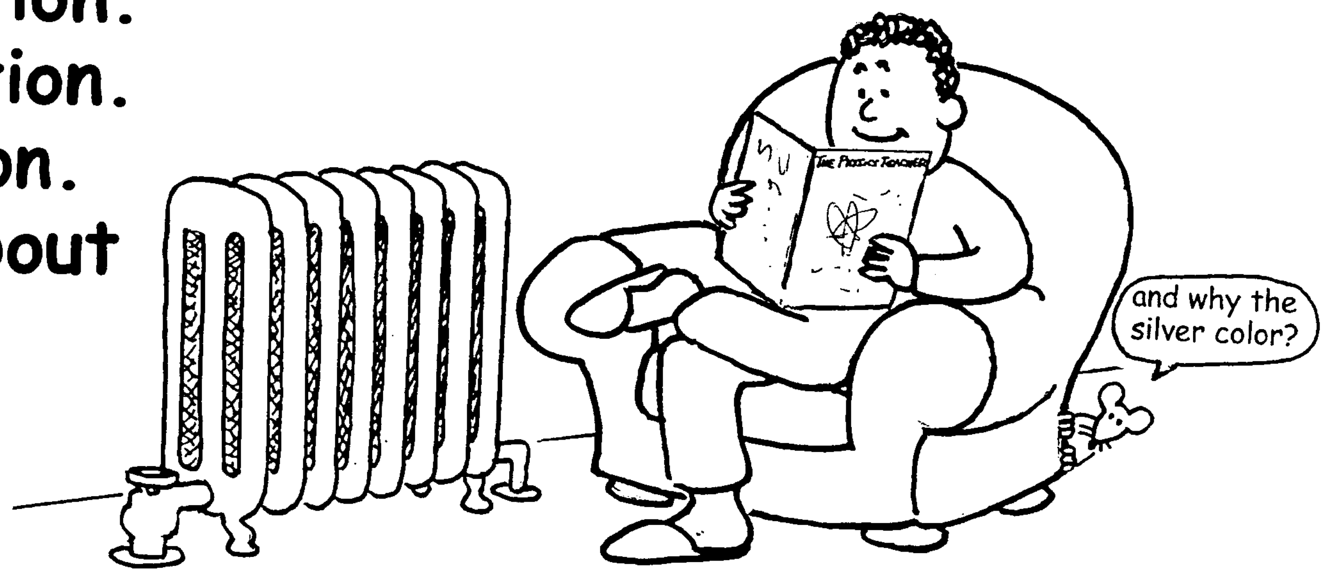
Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

Hot water/steam radiators are common fixtures that nicely warm the interiors of buildings. These radiators warm a room primarily via

a) conduction.
b) convection.
c) radiation.
d) ...all about equally.



thanx to Dean Baird

Hewitt Drew it!

CH 16-7

NEXT-TIME QUESTION

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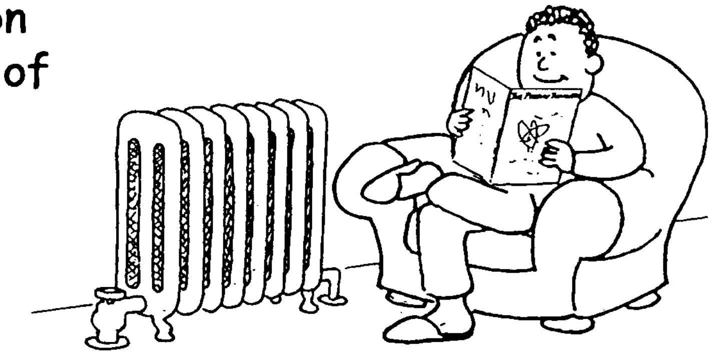
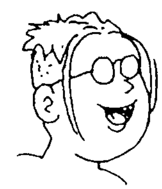


Answer: b, by convection.
The exposed pipework of the radiator is brought to a high temperature by steam or hot water. Air near the radiator is warmed by conduction. The placement of the radiator in a room allows the newly heated air to rise away from the radiator, drawing cooler air toward it. The radiator warms the cool air and the process continues. Convection! Although conduction and radiation play a role, convection is predominant.

Notice how the pipework allows for a vertical flow of air; you never see pipework in a horizontal orientation. Radiators are often painted with highly reflective silverish paint, which reduces emissivity, inhibits radiation, and allows the radiator pipes to become and remain hotter than they otherwise would—increasing their ability to drive convection. Maybe the fixture should be called a "convector?"



Hewitt Drew it!

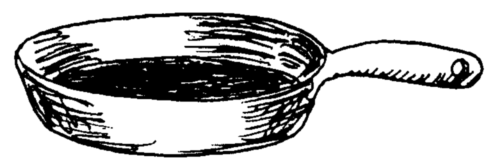
NEXT-TIME QUESTION

CONCEPTUAL Physics

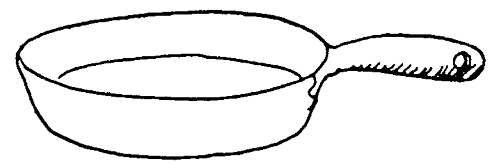
Black-Shiny Cookware

You're a consultant for a cookware manufacturer who wishes to make a pan that will have two features: (1) absorb thermal energy from a flame as quickly as possible, and (2) have an inner surface that remains as hot as possible when cooking.
You should recommend a pan with the

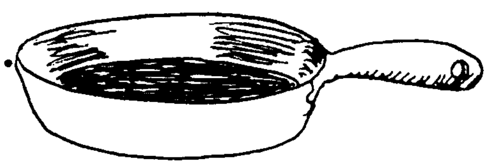
a) outer and inner surfaces black.



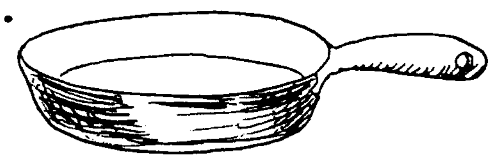
b) outer and inner surface shiny.



c) outer surface shiny and inner surface black.



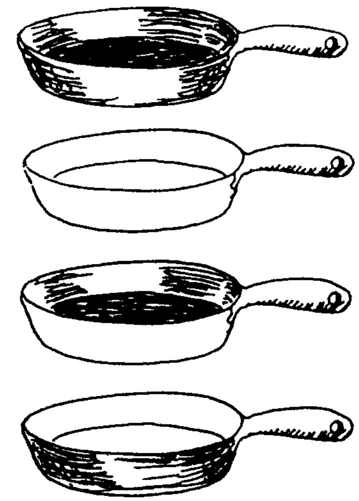
d) outer surface black and inner surface shiny.



thanx to Dean Baird

Hewitt Drew it!

NEXT-TIME QUESTION



You're a consultant for a cookware manufacturer who wishes to make a pan that will have two features: (1) absorb thermal energy from a flame as quickly as possible, and (2), have a cooking surface that stays as hot as possible when heated. You should recommend a pan with the

a) outer and inner surface black.
b) outer and inner surface shiny.
c) outer surface shiny and inner surface black.
d) outer surface black and inner surface shiny.

Answer: d.

The color of cookware matters little to heat transfer by way of conduction and convection, which play significant roles. But for heat transfer by radiation, color is important. Surfaces that absorb more visible light are black, and the same is usually true for infrared radiant energy. Black surfaces absorb radiant energy better than do shiny metal surfaces. So choose black for the outer part of the pan.

For the inside of the pan you want a surface that stays hot—that emits radiant energy poorly. Since a good absorber is a good emitter, you rule against a black inner surface. Shiny surfaces are good reflectors and poor emitters, so the inner surface should be shiny.

The inner and outer surfaces of the pan are continually absorbing and emitting radiant energy. When in use, the outer surface is exposed to the hot flame and is a net absorber, while the inner surface is exposed to the cooler air above and is a net emitter.

Hewitt Drew it!

NEXT-TIME QUESTION

Black-Shiny Space Packaging

You're a consultant to a manufacturer of space gear that wants to encase some instruments in a covering that will have two properties: (1) absorb as little energy as possible on the side of the package facing the sun, and (2) emit as little energy as possible on the side facing away from the sun. You should recommend a covering with

a) the side facing the sun black and the other side shiny.

b) the side facing the sun shiny and the other side black.

c) both sides shiny.

d) both sides black.

thanx to Dean Baird and Ken Ford

Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

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b) the side facing the sun shiny and the other side black.

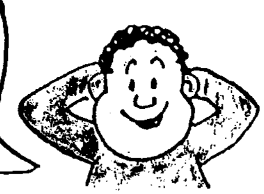
c) both sides shiny.

d) both sides black.

Answer: c.

Surfaces that absorb more light (and usually more infrared radiation as well) are black. So you don't want the side in the sun to be black. Go for shiny, which will reflect rather than absorb energy. Since poor absorbers are also poor emitters, go for shiny on the side facing away from the sun also. So shiny surfaces on both sides of the covering will mean less absorption of solar radiation on one side and less emission on the other.

Light incident upon a surface can be either absorbed or reflected. Usually both occur to some degree. When absorption dominates, the surface is black. When reflection dominates, the surface is shiny. The rate of absorption or reflection depends on surface composition—the *emissivity* of the object's surface.

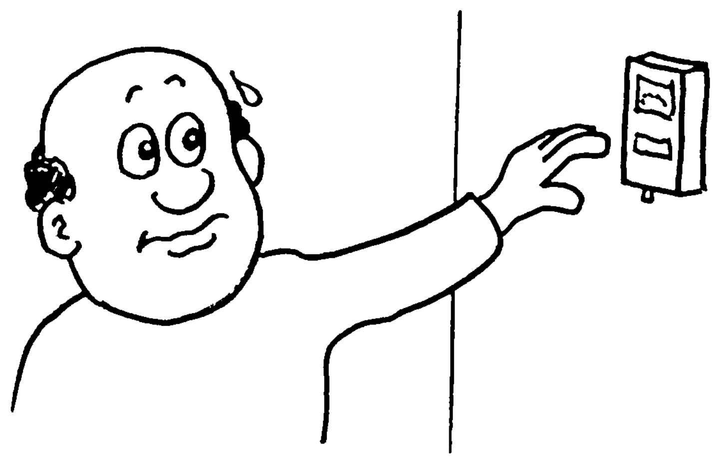


Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

If you wish to save fuel and you're going to leave your cool house for a half hour or so on a very hot day, should you turn your air conditioning thermostat up a bit, turn it off altogether, or let it remain at the cool room temperature you desire?



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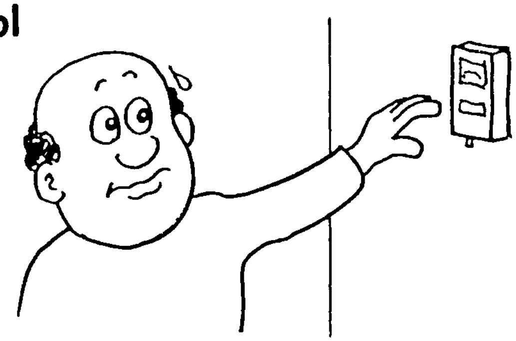


Answer:

Turn your air conditioner off altogether and save fuel. The amount of heat that leaks into your house depends on the insulation and the difference in inside and outside temperature, ΔT. In accord with *Newton's law of cooling*, keeping ΔT high consumes more fuel. When you turn your conditioner off you minimize both ΔT and fuel consumption.

Will more fuel be required to re-cool the house when you return than would have been consumed to keep it cool while you were away? Not at all. When you return and turn your conditioner on again, you extract heat at a smaller ΔT. The amount of fuel consumed to bring room temperature to its original cool setting is less than the amount consumed to keep it at the cool setting continuously.

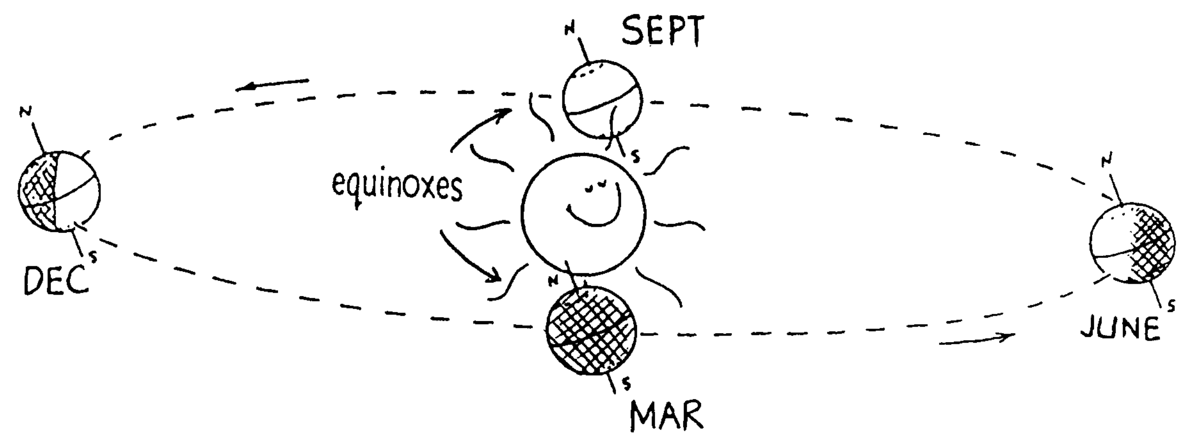
Hewitt Drew it!

NEXT-TIME QUESTION

CONCEPTUAL Physics

The autumn and spring equinoxes are the turning points of Earth s seasons, when all parts of the world should have equal-length days and nights. But as it so happens, even at this special time daylight time is slightly longer than night.

Why?



Hewitt Drew it!

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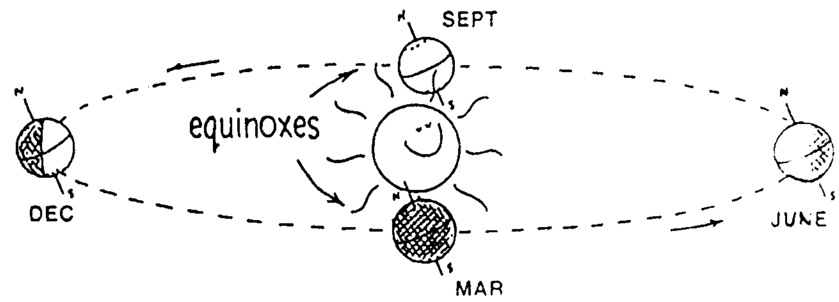
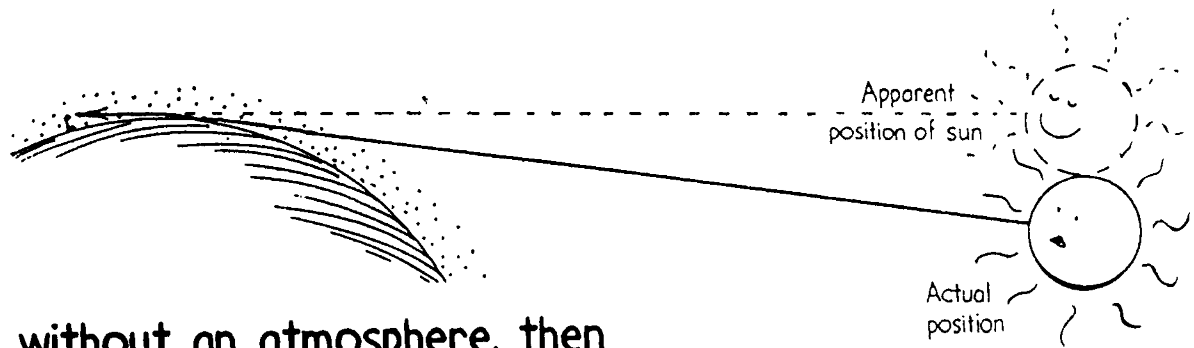
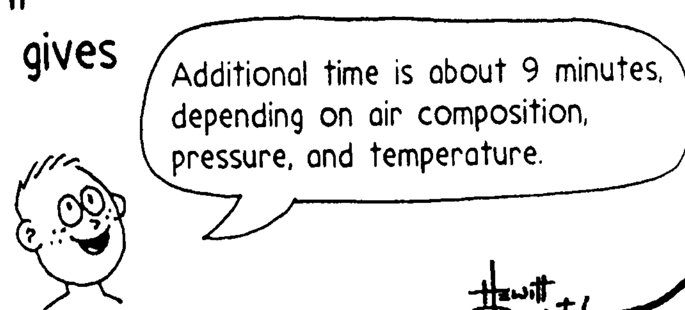




Answer:

If we lived on a planet without an atmosphere, then the times of day and night would be equal during an equinox. But because of atmospheric refraction, the sun rises a few minutes before we would see it if there were no atmosphere. At sunset refraction gives us another few minutes of extra light.



Hewitt Drew it!